

What is claimed is:

1. A bi-directional communication link having plural channels, each of said channels comprising:

- a master connected at a near of the channel and a slave connected at an opposite end of the channel;
- said master comprising:
 - (a) a transmitter coupled to the channel and having a master Tx clock signal;
 - (b) a receiver coupled to the channel and comprising:
 - (i) an analog-to-digital converter that periodically samples at a sampling time T_s ;
 - (ii) a clock recovery circuit that generates a master Rx clock from a clock signal embedded in a signal received from the channel;
 - (iii) a metric processor connected to an output of said analog-to-digital converter that produces a metric signal indicative of resolution of the received signal;
- said slave comprising:
 - (a) a receiver coupled to the channel and comprising a clock recovery circuit for generating a Slave Rx clock from the signal received from the master;
 - (b) a transmitter coupled to the channel and having a Slave Tx clock signal, whereby said master Rx clock signal is frequency locked to said Slave Tx clock signal;
 - (c) a controllable delay element for generating said Slave Tx clock signal from said Slave Rx clock signal;
- said communication link further comprising a decision processor responsive to said metric processor for changing a delay value of said controllable delay element so as to maximize the metric signal.

1 2. The apparatus of claim 1 wherein said resolution is a
2 resolution between leading and trailing edges of the received
3 signal.

1 3. The apparatus of claim 1 wherein said resolution is a
2 resolution between allowed amplitude levels of the received
3 signal.

1 4. The apparatus of claim 1 further comprising a second
2 controllable delay between said Master Rx clock signal and
3 said analog-to-digital converter and responsive to said
4 decision processor, whereby said decision processor delays
5 the Slave Tx clock signal and the sample time T_s
independently to maximize the metric signal.

5. A bi-directional communication link having plural
channels with respective masters and slaves at respective
ends of respective channels, each master issuing a Master Tx
clock, each slave constructing a Slave Rx clock
frequency-locked to the Master Tx clock, and a Slave Tx clock
frequency-locked to the Slave Rx clock, said bi-directional
communication link comprising:

a metric processor for each master that produces a
metric signal indicative of resolution of a signal received
by the master from the corresponding slave; and

a decision processor responsive to said metric
processor for changing the phase of the Slave Tx clock
relative to the Slave Rx clock so as to maximize the metric
signal.

1 6. The apparatus of claim 5 wherein said resolution is a
2 resolution between leading and trailing edges of the received
3 signal.

1 7. The apparatus of claim 5 wherein said resolution is a
2 resolution between allowed amplitude levels of the received
3 signal.

1 8. A bi-directional communication link having plural
2 channels with respective masters and slaves at respective
3 ends of respective channels, each master issuing a Master Tx
4 clock, each slave constructing a Slave Rx clock
5 frequency-locked to the Master Tx clock, and a Slave Tx clock
6 frequency-locked to the Slave Rx clock, wherein the master
7 samples a signal it receives from the slave at a sample time
8 Ts frequency locked to the Master Rx clock, said
9 bi-directional communication link comprising:

10 a metric processor for each master that produces a
11 metric signal indicative of resolution of a signal received
12 by the master from the corresponding slave; and

13 a decision processor responsive to said metric
14 processor for shifting said sample time Ts relative to the
15 Master Tx clock so as to maximize the metric signal.

16 9. The apparatus of claim 8 wherein said resolution is a
17 resolution between leading and trailing edges of the received
18 signal.

1 10. The apparatus of claim 8 wherein said resolution is a
2 resolution between allowed amplitude levels of the received
3 signal.

1 11. A bi-directional communication link having plural
2 channels with respective masters and slaves at respective
3 ends of respective channels, each master issuing a Master Tx
4 clock, each slave constructing a Slave Rx clock
5 frequency-locked to the Master Tx clock, and a Slave Tx clock
6 frequency-locked to the Slave Rx clock, wherein each master
7 receives a periodic noise burst comprising cross-talk from

8 masters of adjacent channels and echoes of itself, said noise
9 capable of reducing the resolution of a signal received by
10 the master from the slave over the corresponding
11 communication, said bi-directional communication link
12 comprising:

13 a metric processor for each master that produces a
14 metric signal indicative of the resolution of the signal
15 received by the master from the corresponding slave; and

16 a decision processor responsive to said metric
17 processor for changing the phase of the Slave Tx clock
18 relative to the Slave Rx clock so as to reduce the effects of
19 the noise burst on the received signal and thereby increase
20 the metric signal.

12. The apparatus of claim 11 wherein said resolution is a
resolution between leading and trailing edges of the received
signal.

13. The apparatus of claim 11 wherein said resolution is a
resolution between allowed amplitude levels of the received
signal.

14. A bi-directional communication link having plural
channels with respective masters and slaves at respective
ends of respective channels, each master issuing a Master Tx
clock, each slave constructing a Slave Rx clock
frequency-locked to the Master Tx clock, and a Slave Tx clock
frequency-locked to the Slave Rx clock, wherein the master
samples a signal it receives from the slave at a sample time
Ts frequency locked to the Master Rx clock, and wherein each
master receives a periodic noise burst comprising cross-talk
from masters of adjacent channels and echoes of itself, said
noise capable of reducing the resolution of a signal received
by the master from the slave over the corresponding

13 communication, said bi-directional communication link
14 comprising:

15 a metric processor for each master that produces a
16 metric signal indicative of the resolution of the signal
17 received by the master from the corresponding slave; and

18 a decision processor responsive to said metric
19 processor for shifting said sample time T_s relative to the
20 Master Tx clock so as to reduce the effects of the noise
21 burst on the received signal and thereby increase the metric
22 signal.

1 15. The apparatus of claim 14 wherein said resolution is a
2 resolution between leading and trailing edges of the received
3 signal.

4 16. The apparatus of claim 14 wherein said resolution is a
5 resolution between allowed amplitude levels of the received
6 signal.

7 17. The apparatus of claim 14 further comprising a
8 controllable delay between said Slave Rx clock and said Slave
9 Tx clock, said decision processor governing said controllable
10 delay so as the shift said sample time T_s .

1 18. The apparatus of claim 15 wherein said metric processor
2 comprises a processor for computing an opening in an eye
3 diagram of the signal received by the master.

4 19. The apparatus of claim 16 wherein said metric processor
5 comprises a processor for computing the proportion of samples
6 of the signal received by the master falling within allowed
7 amplitude levels relative to those that fall outside of
8 allowed amplitude levels.

1 20. In a bi-directional communication link having plural
2 channels with respective masters and slaves at respective
3 ends of respective channels, each master issuing a Master Tx
4 clock, each slave constructing a Slave Rx clock
5 frequency-locked to the Master Tx clock, and a Slave Tx clock
6 frequency-locked to the Slave Rx clock, wherein the master
7 samples a signal it receives from the slave at a sample time
8 Ts frequency locked to the Master Rx clock, and wherein each
9 master receives a periodic noise burst comprising cross-talk
10 from masters of adjacent channels and echoes of itself, said
11 noise capable of reducing the resolution of a signal received
12 by the master from the slave over the corresponding
13 communication, a method of reducing the effects of the
14 cross-talk and echo noise burst on the signal received by
15 each master, comprising:

16 for each master, producing a metric signal
17 indicative of the resolution of the signal received by the
18 master from the corresponding slave; and

19 in response to said metric signal, shifting said
20 sample time Ts relative to the Master Tx clock so as to
21 reduce the effects of the noise burst on the received signal
22 and thereby increase the metric signal.

23 21. The method of claim 20 wherein said resolution is a
24 resolution between leading and trailing edges of the received
25 signal.

26 22. The method of claim 20 wherein said resolution is a
27 resolution between allowed amplitude levels of the received
28 signal.

29 23. The method claim 20 wherein the shifting of said sample
30 time Ts is carried out by changing a delay between said Slave
31 Rx clock and said Slave Tx clock.

1 24. The method of claim 21 wherein the producing of the
2 metric signal comprises computing an opening size in an eye
3 diagram of the signal received by the master.

1 25. The method of claim 22 wherein the producing of the
2 metric signal comprises computing the proportion of samples
3 of the signal received by the master falling within allowed
4 amplitude levels relative to those that fall outside of
5 allowed amplitude levels.

1 26. In a bi-directional communication link having plural
2 channels with respective masters and slaves at respective
3 ends of respective channels, each master issuing a Master Tx
4 clock, each slave constructing a Slave Rx clock
5 frequency-locked to the Master Tx clock, and a Slave Tx
6 clock frequency-locked to the Slave Rx clock, wherein the
7 master samples a signal it receives from the slave at a
8 sample time T_s frequency locked to the Master Rx clock, and
9 wherein each master receives a periodic noise burst
10 comprising cross-talk from masters of adjacent channels and
11 echoes of itself, said noise capable of reducing the
12 resolution of a signal received by the master from the slave
13 over the corresponding communication, a method of reducing
14 the effects of the cross-talk and echo noise burst on the
15 signal received by each master, comprising:

16 for each master, producing a metric signal
17 indicative of the resolution of the signal received by the
18 master from the corresponding slave;

19 for each slave, producing a metric signal
20 indicative of the resolution of the signal received by the
21 slave from the corresponding master; and

22 in response to the metric signal corresponding to
23 the master and to the metric signal corresponding to the
24 slave, shifting said sample time T_s relative to the
25 Master Tx clock so as to reduce the effects of the noise

26 burst on the received signal at both the master and the
27 slave and thereby increase the metric signals corresponding
28 to the master and the slave.